RESEARCH IN INTELLIGENT MEDICAL SYSTEM: PROBLEMS AND SOLUTION

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Abstract

Advancement in computer systems could assist the doctors to make decision without direct consultation with the specialist. Medical information systems were developed in most hospital or health care provider to manage patients' records and enhance the current practice of medical records. A computer program known as Medical Decision-Support System was designed to help health professionals to make clinical decision (Shortliffe, 1987). The system deals with medical data or with the knowledge of medicine to help in determining the nature of the patient's disease to diagnosis or administer therapy. However, developing medical system, especially intelligent medical system could be a difficult task. This paper discusses the experience of doing research in medical domain. The problems encounter and the solutions for future work are presented.

Keywords: *Intelligent medical system, Decision Support System*

1.0 Introduction

Medical expertise cannot be produced as early as manufacturers produce their goods. Specialist require a few years of training in order to train themselves to be an expert in certain specialization on areas. Therefore, the insufficient number of medical expertise cannot be overcome in a short time period. Higher educational institutions such as universities and colleges could however, take immediate actions to produce as many qualified doctors as possible. However, while waiting for a student to become a doctor and the doctor to become an expert, many patients may die.

The problem arises here is not that the clinician or the General Practitioners do not have the qualifications to treat patients with high-risk disease, however the main concern is that, their knowledge and experience to deal with high-risk diseases is not enough. They often require advice from an expert in the disease domain before they could make decisions. Consulting the experts will be costly and time consuming as the experts have to deal with their own patients and research. A preliminary survey reported in Manamohan and Deraman (2000) for example, indicates that patients have to takes approximately two month in order to consult the cardiologist. Therefore, the medical system was designed and developed to assist clinicians in providing specialize health care and manage the patient's data (or records).

Capturing knowledge from a medical specialist is not an easy task. The medical specialist needs to express his knowledge structurally so that his knowledge can be translated and transferred correctly into the form that can be understood by the computer. However, in many applications such as medicine, the rules applied are too many. As each step is crucial in medical diagnosis, avoiding one step could cause misinterpretation or wrong diagnosis. If too many rules are involved, more time is consumed to translate, transfer and classify the knowledge. Therefore, a new approach need to be explored so that the medical system can be equipped with many rules as possible and yet the training time is reduced without affecting the prediction accuracy of the proposed approach.

2.0 Study Background

Prediction model has long been used in many applications such as financial, business, education, medical and other. The prediction models that have been used in medical can be classified into two categories. The first category is the statistical model known as regression. The more recent technique that has been applied in medical is Artificial Intelligence technique, in particular Neural Network (NN) approach. Many studies have shown the advantages of NN over other traditional modeling techniques such as logistic regression (Pofahl *et al.*, 1998, Dybowski *et al.*, 1996). One of the areas that NN has

been applied to is a survival analysis. Survival analysis plays an important role in determining the patient's condition after contracting a serious illness. The goal of the survival analysis is to estimate the chance of patient's survival as a function of time. Suryival analysis is a classification problem in which patients are categorized into several groups based on how serious their diseases are. Patients with high prognostic estimation would be considered to receive intensive care. Many research have been dedicated to the application of NN in medical applications concerning the survival of the patients, predicting the presence of disease or disease levels and disease patterns.

For patients who have chronic breast cancer for example, survival analysis could be used for individual prognosis, as a patient would want to know how long he or she is likely to survive. For clinicians, this prognostic estimation provides them some data that can be better interpreted for the future cases. In addition, it helps both the clinician and the patient's family to prepare for any circumstances. NN is one of the tools that can be used for survival analysis. Ohno-Machado (1996) for example constructed sequential NN for the estimation of HIV patient survival time. Another study shows NN whose structure was selected by means of genetic algorithm predicted hospital mortality more accurately as compare to logistic regression model (Dybowski *et al.*, 1996). A combination of NN and Bayesian network could also provide a good estimation of patient's prognosis (Bakker and Heskes, 1999; Bakker *et al.*, 2000).

A large number of data involves in training the network, NN can be too complex and difficult to train. Therefore, the main focus of this study is to minimize the NN complexity by using multi-network approach to represent data. Using this approach, more data or rules could be represented into the system without affecting its performance.

3.0 The Problems

As for a new technology, the problems always arise. The most common problems are (Kokol and Druzovec, 2001):

- Resistance against the technology – because of personal conflict, fear of unemployment and Frankensteins effect (fear of "automatic" concurrence).
- Lack of time – no time to participate.
- Lack of knowledge on information technology,
- Misjudgment of the engineering process of intelligent systems development.

Therefore, because of the time limit and lack of interaction and understanding between researcher and medical practitioners the collection of data became a major problem. The data used in the study was obtained from Alor Setar General Hospital Kedah with a written permission from the Ministry of Health. However, medical data is too complex and non-medical background reader could easily misinterpret the data. This is because medical Decision-Making is a complex process that exhibits both scientific and artistic features (Moustakis and Charissis, 1999). In addition, modelling expert knowledge is expensive, unreliable and time-consuming (Sierra and Larranaga, 1998). Therefore, the data collection process is difficult. To overcome the problem, the data used in this study is simulated based on the real data pattern. Each variable is represented in Boolean representation that is 0 or 1. These data formed logical representations of patients' data. Several patients' data are also collected from the hospital. These data are used to demonstrate the system that has been developed. As the system uses Boolean values, the data used for the training and test sets are either 1 or 0. Although the network did perform as expected, the use of confidence values to represent the actual data may yield more "human-like" prediction system.

Training the network with Boolean data makes the network learns the pattern as a true or false which is a straightforward problem. Hence, applying the knowledge in application domain is not really predictive. However, the network did perform as expected. For example, applying the knowledge of AND's network to AND problem will produce the results of AND. Therefore, to improve the network ability, real data is required.

4.0 Solutions for Future Research

This study focused on the implementation of multi-network approach using Myocardial Infarction disease as the domain. Although, the research meets the objectives, many efforts have to be made to enhance the research. For example, as one of the major problem faced in the study is data gathering,

the action need to be taken to overcome the problem. Therefore, several things need to be made and implemented, namely centralized medical system, research and collaboration and integration of research.

Centralized Medical System

Centralized medical information system (Figure 1) is proposed to manage patients and patients' related data for current and future used. In this context centralized medical information system means a centralized information sources where all data relating to patients' and patients' illness, as well as treatment (diagnosis and prognosis) are stored. This concept could be later expanded to distributed information system (according to the current system engineering processes and requirement) to speed up the access and to meet its flexibility to more advance applications.

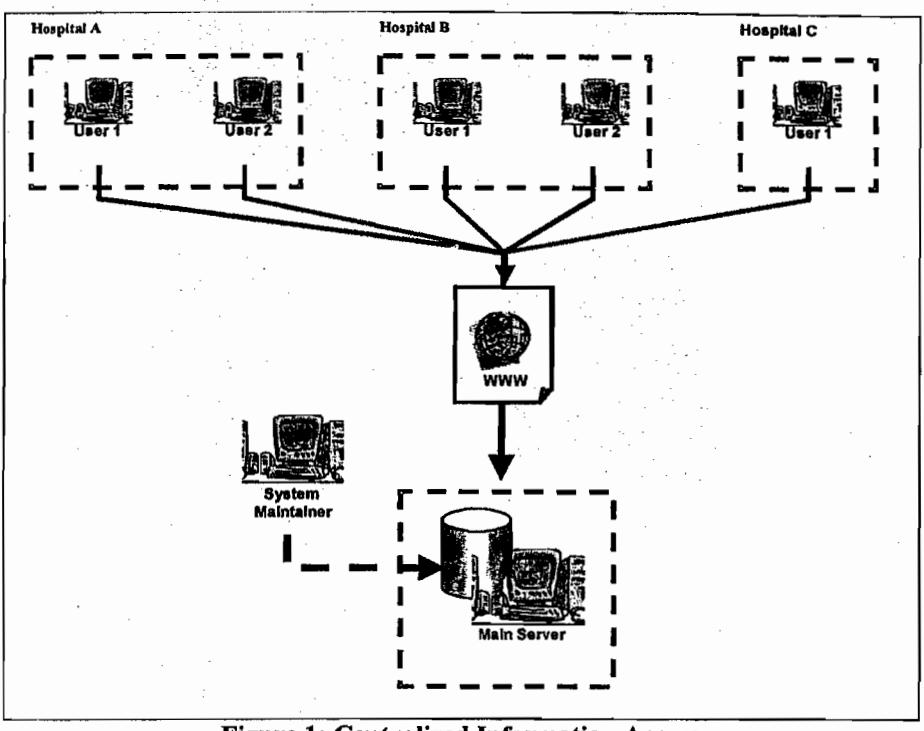

Figure 1: Centralized Information Access

The potentials or the importance of centralized information resources in medicine are summarized as follows (*in* Wan Ishak *et al.*, 2000):

a) Improved patients record storage
b) Information sharing between hospitals
c) Enhance storing and retrieving patients information
d) Diagnosis and patients monitoring
e) Updating and managing databases
f) Assist management and doctors in preparing annual report and statistics
g) Promote telemedicine
h) Distribution of knowledge between researchers in medicine
i) Encourage research in medicine

Research and Collaboration

Typically, one research could not survive without another. This is because researchers might require other knowledge to run their research. Statistician for example, who uses economical data to predict the economy breakdown, requires some thought or knowledge from economist to develop the prediction model. However, consulting other people might be not as easy as it should be. Some people might be to busy and some other might be not really cooperative. In many cases, the main problem is due to the communication gap between fields. Statistician for example, might not understand economic term or model by his own. He needs to consult the economist for the definition and the relation between variables to enable him to develop his model. However, when expressing his research need,

the economist might not understand his need and the economist might give different feedback or too detail explanation that is not in the research scope. Therefore, the collaboration is required between both fields so that every people understand the research scope and its need. With collaboration, the process of gathering the data could be minimized, as the expert himself became a part of the research team. Statistician can concentrate his time to the data analysis and prepare the research tools rather than worried about data collection and interpretation.

Integration of Research

Artificial Intelligence and other sciences comprises of many smaller fields or domain. Each of these domains usually concentrates on one aspect of application. In Artificial Intelligence many branches has been developed such as Neural Networks, Fuzzy Logic, Genetic Algorithm, Expert System and many more. These branches usually specialize in one specific domain and are able to perform some limited function. Expert system for example is a very famous technique. It has been used in developing several intelligent systems for diagnosis purposes. However, when facing problem with ambiguity, expert system might not give a correct result or interpretation.

Fuzzy logic, which has been developed to deal with fuzzy data, could be integrated with an expert system to increase its diagnostic ability. However, fuzzy logic and expert system is two different domains that require more knowledge and skills. Therefore, the integration of research in these two domains would be an advantage. The researchers do not have to master both skills yet both could use their skill and expertise to enhance the system or their research output.

5.0 Conclusion

Experts believe that medicine in the twenty first century will be different than medicine in the late twentieth century (Altman, 1999). As the time goes, computer roles in health care have increased. At first, computer was used as an aid for medical diagnosis. AI techniques, namely expert system was then employed in medical diagnosis to simulate human expert reasoning. It was then expanded in patient management and in more advanced research; molecular medicine (Altman, 1999). Altman have summarized the era of AI in medical research into three eras namely, era of diagnosis, era of managed care and era of molecular medicine (illustrated in Figure 2).

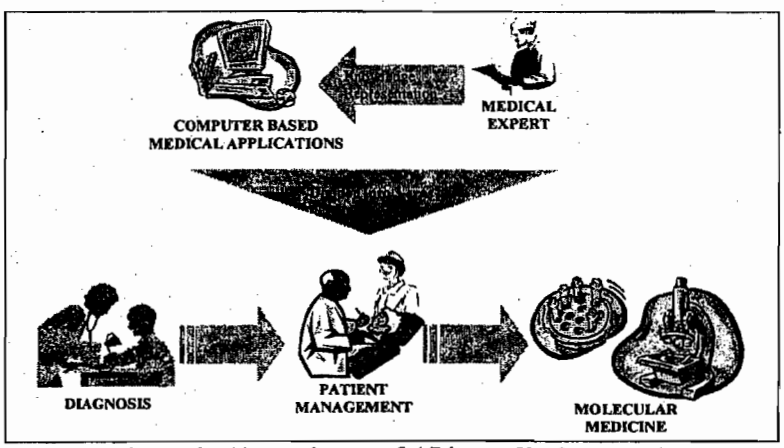

Figure 2: Altman's era of AI in medical research

Therefore, to ensure the success of the research the researchers need to be as close as it can be to the source of knowledge. Hence, medical specialist needs to take their part by working together and provide the necessary information to the researchers. Another alternative is the specialist himself became one of the researchers so that he could apart of the research. This contribution will benefit not only to the non-medical researchers but also to both parties

References

Altman, R. B. (1999). AI in Medicine: The Spectrum of Challenges from Managed Care to Molecular Medicine. *AI Magazine, 20(3)*, 67-77.

Bakker, B., and Heskes, T. (1999). A neural-Bayesian Approach to survival analysis, *Proceedings ICANN'99*, 832-837.

Bakker, B., Kappen, B., and Heskes, T. (2000). Surival Analysis: A neural-Bayesian approach. *Proceedings ANNIMAB-1*.

Dybowski, R., Weller, P., Chang, R., and Gant, V. (1996). Prediction of Outcome in the Critically Ill Using an Artifical Neural Network Synthesised by a Genetic Algorithm. *Appear in the Lancet*.

Kokol, P., and Druzovec, T. W. (2001). Some Ideas about Intelligent Medical System Design. *Health Informatics Europe On-line Journal*. Retrieved January 31, 2002 from the World Wide Web: http://www.hi-europe.info/files/1998_9/imsd_kokol_etal.htm.

Manamohan, B. E., and Deraman, Aziz. (2000). ICDC: Sistem Diagnostik Penyakit Jantung. *Proceeding of Information Technolgy Symposium 2000*, (pp. 45-48), Bangi: Universiti Kebangsaan Malaysia.

Moustakis, V., and Charissis, G. (1999). Machine Learning and Medical Decision Making. *Proceeding of Machine Learning and Applications: Machine Learning in Medical Applications*, (pp. 1-19), Chania, Greece.

Ohno-Machado, L. (1996). Medical Applications of Artificial Neural Networks: Connectionist Model of Survival. *Ph.D Dissertation.* Stanford University.

Pofahl, W. E., Walczak, S. M., Rhone, E., and Izenberg, S. D. (1998). Use of an Artificial Neural Network to Predict Length of Stay in Acute Pancreatitis. *Presented as a poster at the 66th Annual Scientific Meeting and Postgraduate Course Program January 31-February 4*.

Shortliffe, E. H. (1987). Computer Programs to Support Clinical Decision Making. *Journal of the American Medical Association, 258(1)*.

Sierra, B., and Larranaga, P. (1998). Predicting the survival in malignant skin melanoma using Bayesian networks automatically induced by genetic algorithms. An Empirical comparision between different approaches. *Artificial Intelligence in Medicine, 14(1, 2)*, 215-230.

Wan Ishak, Wan Hussain., Siraj, Fadzilah., and Othman, Abu Talib. (2000). Pengurusan Pangkalan Data Berpusat Bagi Pesakit Di Hospital. *Presented at Graduate Research Management Symposium (15-16 November 2000)*, Universiti Utara Malaysia.